Worksheet – Newton's 2nd Law of Motion

#1 $m = 79\ kg$ ⊕ →

$\vec{a} = 1.4 m/s^2$ [R]

$\vec{F}_{NET} = ?$

$\vec{F}_{NET} = m\vec{a}$

$= 110.6 N$ [R]

#2 a) $m = 5.0\ kg$ ⊕ →

$\vec{a} = 5.0 \times 10^3 m/s^2$

$\vec{F}_{NET} = ?$

$\vec{F}_{NET} = m\vec{a}$

$= 2.5 \times 10^4 N$ [fwd]

b) $m = 28g = 0.028\ kg$

$\vec{a} = 2.5 \times 10^3 m/s^2$ [E]

$\vec{F}_{NET} = ?$

$\vec{F}_{NET} = m\vec{a}$

$= 7.0 \times 10^1 N = 70 N$ [E]

c) $m = 1.6 \times 10^5\ kg$

$\vec{a} = 1.2 m/s^2$ [S]

$\vec{F}_{NET} = ?$

$\vec{F}_{NET} = m\vec{a}$

$= 1.92 \times 10^5 N$ [S]

#3 $m = ?$

$\vec{F}_{NET} = 32 N$ [N]

$\vec{a} = 0.88 m/s^2$ [N]

$\vec{F}_{NET} = m\vec{a}$

$32 = m(0.88)$

$m = 36.4\ kg$

#4 $m = ?$

$\vec{F}_{NET} = 720 N$ [fwd]

$\vec{a} = 180 m/s^2$ [fwd]

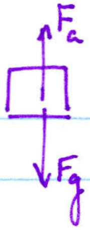
$\vec{F}_{NET} = m\vec{a}$

$720 = m(180)$

$m = 720/180$

$= 4.0\ kg$

#5 a)



b) WEIGHT = $F_g = mg = 666.4N$ [DOWN]

c) $\vec{F}_{NET} = \vec{F}_a + \vec{F}_g$ (since we know the values of the two forces not the acceleration)

taking up as positive

$\vec{F}_{NET} = 777 - 666.4$

$= 110.6N$ [UP]

d) Since we now know what the net force is ... → $\vec{F}_{NET} = m\vec{a}$

$110.6 = 68\vec{a}$

$\vec{a} = 1.63 m/s^2$ [UP]

#6 $m = 820 kg$

$\vec{v}_1 = 0 m/s$

$\Delta\vec{d} = 41 m$

$\Delta t = 3.0 s$

$\vec{F}_{NET} = ?$

In order to determine F_{NET} we require the acceleration:

$\Delta\vec{d} = \vec{v}_1\Delta t + \frac{1}{2}\vec{a}\Delta t^2$

$41 = 0 + \frac{1}{2}\vec{a}(3)^2$

$\frac{82}{9} m/s^2 = \vec{a}$

$\vec{F}_{NET} = m\vec{a}$

$= 820\left(\frac{82}{9}\right)$

$= 7471 N$

#7 $m = 21g = 0.021kg$

$\vec{v}_1 = 18cm/s = 0.18 m/s$

$\vec{v}_2 = 28cm/s = 0.28 m/s$

$\Delta t = 0.10 s$

We have to assume here that the force provided to accelerate the blood comes solely from the heart muscle.

Thus, $\vec{F}_{NET} = \vec{F}_{heart\ muscle} = m\vec{a}$

To determine "$\vec{a}$",

$\vec{v}_2 = \vec{v}_1 + \vec{a}\Delta t$

$0.28 = 0.18 + \vec{a}(0.1)$

$\vec{a} = 1 m/s^2$

$\therefore \vec{F}_{NET} = (0.021)(1)$

$= 0.021 N$

#8 $\vec{F}_{NET} = 15N$ [fwd]

$m = 2.1kg$

$\vec{a} = ?$

(a) $\vec{F}_{NET} = m\vec{a}$

$15 = 2.1\vec{a}$

$\vec{a} = 7.14 m/s^2$ [fwd]

(b) $\Delta t = ?$ ⊕→

$\vec{v}_1 = 0 m/s$

$\Delta\vec{d} = 2.8m.$

$\vec{a} = 7.14 m/s^2$

$\Delta\vec{d} = \vec{v}_1\Delta t + \frac{1}{2}\vec{a}\Delta t^2$

$2.8 = 0 + \frac{1}{2}(7.14)\Delta t^2$

$\Delta t = 0.886 s$

#9 (a) UNIFORMLY.... $\vec{F}_{NET} = 0N$

$\vec{F}_{NET} = \vec{F}_a + \vec{F}_g$

$0 = F_a - F_g$

$F_a = F_g$

$= mg$

$= 20(9.8)$

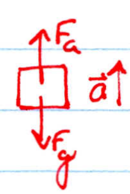
$= 196N$

(b) NON-UNIFORMLY..... OBJECT IS ACCELERATING & THEREFORE $\vec{F}_{NET} \neq 0N$

$\vec{F}_{NET} = m\vec{a}$

$= 20(1.5)$

$= 30N$



$\vec{F}_{NET} = 30N$

$F_a - F_g = 30N$

$F_a = 30 + F_g$

$= 30 + 196$

$= 226N$

#10

$\Delta\vec{d} = 0.80m$

$\vec{V}_2 = ?$

$\vec{V}_1 = 0 m/s$

$m = 5.0g = 0.005kg$ }
$\vec{F}_{NET} = 46N$ [fwd] } use info to derive acceleration

$\vec{F}_{NET} = m\vec{a}$

$45 = 0.005\vec{a}$

$\vec{a} = 9000 m/s^2$

Knowing "$\vec{a}$" we can now use one of the kinematic eqn's to solve for V_2.

$$\vec{V}_2^{\,2} = \vec{V}_1^{\,2} + 2\vec{a}\Delta\vec{d}$$

$$= 0 + 2(9000)(0.8)$$

$$\vec{V}_2 = 120 m/s.$$

#11 Anna Litreal is not correct. The force of gravity is determined by $F_g = mg$. If a bowling ball has mass M and marble mass "m", then

$F_{g_{BBall}} = Mg$ }
$F_{g_{marble}} = mg$ } Clearly, two different values.

Why then, do they fall at the same rate?

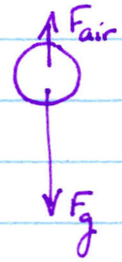
FBD 

$\vec{F}_{NET} = \vec{F}_g$

$\cancel{m}\vec{a} = \cancel{m}\vec{g}$ $\qquad$ $\cancel{M}\vec{a} = \cancel{M}\vec{g}$

$\vec{a} = \vec{g}$ $\qquad$ $\vec{a} = \vec{g}$

#12 a)



⇒ Unbalanced forces.
Net force acts downward. ∴ $\vec{a}$ downward

b)

⇒ Forces are still unbalanced but $\vec{F}_{NET}$ has become smaller ∴ $\vec{a}$ downward but much smaller

c) Once $F_{air} = F_g$ in magnitude, the forces are balanced and the object stops accelerating. It is now travelling at a constant speed (often called terminal velocity).

d) Before we begin, look at the dynamics of the falling raindrop:

$$\vec{F}_{NET} = \vec{F}_g = mg$$
$$= (0.002)(9.8)$$
$$= 0.0196\,N. \leftarrow \text{force of impact.}$$

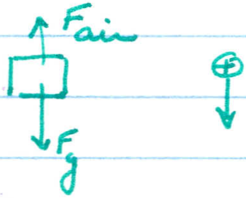
i) With what velocity would it strike the head?

$$\vec{F}_{NET} = m\vec{a}$$
$$mg = m\vec{a}$$
$$\vec{a} = g$$
$$= 9.8\,m/s^2 ! \text{ aka free-fall.}$$
$$\vec{v}_1 = 0\,m/s$$
$$\Delta\vec{d} = (500 - 1.8)\,m.$$

$$\vec{v}_2^{\,2} = \vec{v}_1^{\,2} + 2\vec{a}\Delta\vec{d}$$
$$= 0 + 2(9.8)(500 - 1.8)$$
$$\vec{v}_2 \doteq 99\,m/s$$
$$\doteq 356\,km/h$$

Is this likely? Hmmm.

#13 (a)



(b) $\vec{F}_{NET} = \vec{F}_{air} + \vec{F}_g$

$= -14 + 22N$ ← weight is F_g on box.

$= 8N$ [down]

(c) We obtain the mass of the box from its weight:

$F_g = mg$

$22 = m(9.8)$

$m = \frac{22}{9.8} = 2.24\,kg$

To obtain its acceleration:

$\vec{F}_{NET} = m\vec{a}$

$8 = 2.24\vec{a}$

$\vec{a} = 3.57\,m/s^2$ [down]